

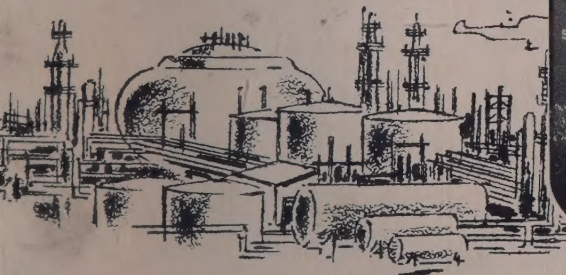
OPERATION AND MAINTENANCE INSTRUCTIONS
PUBLICATION PI-2001-1

*Thermo
Electric*

PORTABLE

MINIMITE[®]

PYROMETER INDICATOR



THERMO ELECTRIC Co., Inc. • Saddle Brook, New Jersey

Temperature Measuring Systems and Components

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*Thermo
Electric*

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GUIDE TO THE USE OF THIS BOOK

Each "MiniMite" has a double-range scale. The four types of scales furnished, and examples of calibrations available, are listed below:

1. **Temperature scale:** 0 to 1800°F Iron/Constantan and 0 to 2400°F Chromel/Alumel.
2. **Combination temperature-millivolt scale:** 0 to 600°F Iron/Constantan and -2.0 to +16.0 mv.
3. **Millivolt scale:** 0 to 32 mv and 30 to 62 mv.
4. **Overlapping or extended temperature scale:** 0 to 650°F and 600 to 1200°F.

The "MiniMite" can be used in one of four different ways:

1. **Direct measurement of temperature using a thermocouple.**
2. **Direct measurement of millivolt signals.**
3. **Calibration of potentiometer-type instruments.**
4. **Calibration of millivoltmeter-type instruments.**

Depending upon the type of temperature check required, and the type of scale with which "MiniMite" is equipped, locate the appropriate section in the Table of Contents, and proceed as instructed.

The instructions for calibrating potentiometers and millivoltmeters are based on the "MiniMite" cold-junction reference temperature factory setting of either 75°F or 25°C. The Thermo Electric Co., Inc. temperature millivolt tables are based on these same cold-junction reference temperatures. When calibrating instruments or using temperature-millivolt tables with cold-junction reference temperatures other than 75°F. or 25°C, appropriate corrections must be made.

The serial number on the name plate on the side of the case identifies each instrument. Always refer to the serial number and model number in correspondence or when ordering spare parts.

A booklet containing temperature millivolt tables for the most commonly used thermocouple calibrations is available upon request to Thermo Electric.

1. PRINCIPLES OF OPERATION

1-1 The potentiometer circuit is an accurate and reliable method of measuring voltage and, therefore, thermocouple temperature. Figure 1 is a circuit diagram of the "MiniMite" potentiometer indicator circuit. The battery supplies a current which causes a voltage differential (E_s) along the potentiometer slidewire and the resistors between points A and B. A part of this voltage differential (E_s) is opposed by the unknown thermocouple voltage (Emf). The slidewire contact (S) is then adjusted until the galvanometer (G) shows no deflection. At this time the thermocouple voltage is equal and opposite to the voltage at the slide-

wire contact.

$$\text{Emf} = E_s - E_t$$

1-2 Cold-junction compensation is obtained by the temperature-responsive resistor (R_t) which is located at the binding post terminals. R_t changes in resistance in proportion to cold-junction temperature variations. This resistance in turn effects voltage differential (E_t). The cold-junction compensation resistor (R_t) is used only when temperatures are being measured by a thermocouple which has its reference junction connected to the instrument binding posts. When an unknown voltage is to be measured using a millivolt scale, R_t

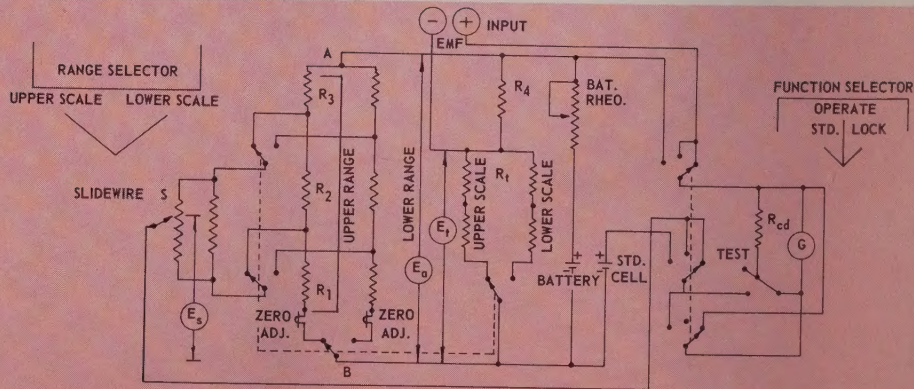


Figure 1. Schematic Diagram, "MiniMite".

1. PRINCIPLES OF OPERATION

must be a non-temperature-responsive resistor, so that E_t will not vary and a true indication of potential will be shown by the position of the slide-wire contact.

1-3 To standardize the circuit, the galvanometer (G) is switched out of the thermocouple circuit and connected in series with the standard cell. The standard cell also opposes the resistor voltage differential, E_a , produced by current from the battery.

1-4 If the scale is to read correctly, this voltage differential, E_a , must remain equal to the standard cell voltage. The battery rheostat (R_{bat}) is adjusted until the voltage, E_a , is equal and opposite to the voltage of the standard cell. When this condition exists, there is no deflection of the galvanometer, and the instrument is said to be "standardized".

1-5 *Switch Functions.* A description of the functions of switches provided on the MiniMite is furnished in the following paragraphs. Refer to figures 1 and 2 for item location and circuitry information.

1-6 *Scale Knob.* The scale knob is used to position the instrument slidewire and the indicator scale to which it is coupled. When the slidewire is positioned so that the MiniMite emf is exactly equal and opposite to the measured emf (galvanometer deflection is at zero), the hairline will be positioned over the indicator scale at the value of the measured emf.

1-7 *Function Selector.* The function selector switch is used to switch between the "standardize,"

"operate", and "lock" positions. It is placed in the STD. position when standardizing to correct for battery voltage loss, in the OPERATE position when using the instrument for measurement, in the LOCK position at all other times. When the function selector is in the LOCK position (see paragraph 1-10) the instrument can be used to furnish voltage output at the terminals without deflecting the galvanometer.

1-8 *Standard Adjust.* The standard adjust knob is used to adjust the battery rheostat to compensate for any variation in battery voltage.

1-9 *Range Switch.* The two-position range switch is used to select the circuit required for either of the two ranges provided on the double range scale.

1-10 *Test Pushbutton.* The TEST pushbutton switches the galvanometer into the measuring circuit. The pushbutton is depressed to measure emf. It is also used to furnish voltage to output terminals when function selector is in "lock" position. When the MiniMite is used for temperature measurements or checking other instruments the test button must be placed in the TEST position. This can be done in either of two ways: (1) depress the Test pushbutton switch manually and hold it in or (2) rotate the Test pushbutton until the *white line* on the button is vertical, in which case the switch will be held in the TEST position.

The Test pushbutton must be released, that is, the *white line* should be horizontal, when the instrument is being zeroed or standardized.

2. PRE-OPERATION CHECKS

2-1 The instrument (see figure 2) must be zeroed and standardized before operation as outlined below. The TEST pushbutton must be released.

2-2 *Mechanically Zeroing The "MiniMite": (Instrument shall be zeroed each time location of "MiniMite" is changed.)*

2-3 Turn switch (2) to OPERATE position and, by means of a small screwdriver, adjust the zero adjust screw (4) until the galvanometer pointer (7) is at "0".

2-4 *Electrically Standardizing the Potentiometer Circuit for Selected Ranges: (To insure accurate readings, instrument should be standardized prior to taking reading.)*

2-5 Turn switch (2) to STD. and hold, while adjusting STD. ADJ. knob (3) until galvanometer pointer (7) is at "0".

CAUTION

Whenever instrument is not in use, the function switch must always be placed in the LOCK position (for carrying or storage) to prevent damaging the galvanometer.

NOTE

Accurate temperature measurements and precise calibration checks will depend largely upon the care exercised in zeroing and standardizing the "MiniMite". If the "MiniMite" will not standardize, replace the battery as instructed in paragraph 7-2.

1. Scale knob
2. Function selector
3. Standardizing adjustment knob
4. Galvanometer zero adjustment
5. Positive terminal
6. Negative terminal
7. Galvanometer
8. Range selector
9. Double-range temperature and/or millivolt scale
10. Test pushbutton

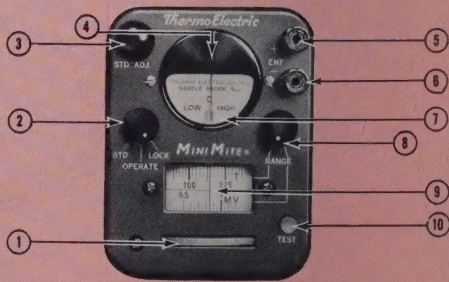


Figure 2. Photo, "MiniMite", Front View.

3. MEASUREMENT OF TEMPERATURE USING A THERMOCOUPLE

3-1 GENERAL

3-2 *"MiniMite" Equipped with a Temperature Scale.*

3-3 **"MiniMite" Calibrated To The Same Curve As The Thermocouple Employed:**

3-4 Connect the thermocouple extension leads from the thermocouple to the "MiniMite" terminal posts (5) and (6). **OBSERVE POLARITY.** Be sure that the connections are secure.

3-5 Move the range selector switch (8) to the scale range corresponding to the calibration of the thermocouple employed.

3-6 Zero and standardize the circuit as instructed in Section 2.

3-7 Press "Test" button (10). Galvanometer pointer (7) will deflect. Turn scale knob (1) until pointer (7) is at "0" and read the thermocouple temperature directly on the scale (9).

3-8 **"Mini-Mite" NOT Calibrated To The Same Curve As The Thermocouple Employed:**

3-9 Follow procedure outlined in paragraphs 3-4 through 3-6.

3-10 Move range selector switch (8) to either of the two temperature scales.

3-11 Press "Test" button (10). Galvanometer pointer (7) will deflect. Turn scale knob (1) until

galvanometer pointer (7) is at "0" and read the thermocouple temperature directly on the scale (9).

3-12 Translate the temperature determined in paragraph 3-11 to millivolts by using the temperature millivolt table corresponding to the calibration selected in paragraph 3-10.

3-13 Make a cold junction correction as follows:

3-14 Measure the cold-junction (terminal post) temperature with a glass thermometer or as outlined in paragraphs 5-9 through 5-11.

3-15 Translate the cold-junction temperature into millivolts using the temperature millivolt table corresponding to the scale calibration selected in paragraph 3-10.

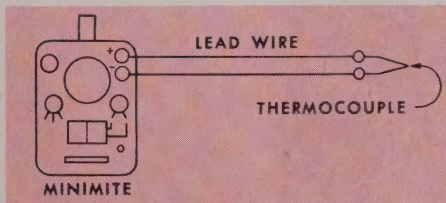


Figure 3. Measurement of Temperature Using a Thermocouple.

3-16 Subtract the resulting cold-junction millivoltage from the hot-junction millivoltage determined in paragraph 3-12. This is a true value in millivolts of the thermocouple emf.

3. MEASUREMENT OF TEMPERATURE USING A THERMOCOUPLE

3-17 Refer to the millivolt table corresponding to the calibration of the thermocouple employed and determine the millivoltage of the cold-junction (terminal post) temperature to the true thermocouple emf. Convert this millivoltage to temperature. The result is the true temperature of the thermocouple.

3-18 *"MiniMite" Equipped with a Combination Temperature-And-Millivolt Scale.*

3-19 **"MiniMite" Calibrated To The Same Curve As The Thermocouple Employed:**

3-20 Follow procedure outlined in paragraphs 3-4 through 3-7.

3-21 **"Mini-Mite" NOT Calibrated To The Same Curve As The Thermocouple Employed:**

3-22 Follow paragraphs 3-4 and 3-6.

3-23 Move range selector switch (8) to MV.

3-24 Press "Test" button (10). Galvanometer pointer (7) will deflect. Turn scale knob (1) until galvanometer pointer (7) is at "0", and read the millivolt value directly on the scale (9).

3-25 The scale reading in millivolts must now be corrected for cold-junction temperature, and converted back into the temperature corresponding to the calibration of the thermocouple employed.

3-26 Measure the cold-junction (terminal post) temperature using a glass thermometer, or as outlined in paragraphs 5-7 through 5-11 using the temperature scale.

3-27 Translate the cold-junction temperature into millivolts using the temperature-millivolt table corresponding to the type of thermocouple employed.

3-28 To the millivoltage of the cold-junction (terminal post) temperature found in paragraph 3-27 above, algebraically add the scale reading in millivolts determined in paragraph 3-25 and convert the resultant millivoltage back into temperature.

3-29 *"MiniMite" Equipped with a Millivolt Scale'*

3-30 Follow paragraphs 3-22 through 3-25.

3-31 Measure the cold-junction (terminal post) temperature using a glass thermometer.

3-32 Using a temperature-millivolt table corresponding to the calibration of the thermocouple employed, convert the cold-junction temperature to millivolts, and algebraically add this millivoltage to the scale reading determined in paragraph 3-24.

3-33 Translate millivolts into temperature. The result is the true temperature of the thermocouple.

4. CHECKING POTENTIOMETER-TYPE INSTRUMENTS

4-1 DIRECT THERMOCOUPLE READING

4-2 The calibration of potentiometer type instruments may be checked by reading the thermocouple temperature using the instrument under test and then comparing this reading with the "MiniMite" reading. "MiniMite" is used, in this case, with a test thermocouple located adjacent to the thermocouple of the instrument under test. Simply follow the appropriate procedure in Section 3, depending upon the scale calibration of the "MiniMite" being used. This is a quick, but at times, inaccurate method of calibration, since "adjacent" thermocouples may not be at equal temperatures.

4-3 DIRECT COMPARISON OF INSTRUMENTS

4-4 When a more positive method of calibration is desired than that described above, follow the appropriate instructions below, depending upon the scale calibration of the "MiniMite" being used.

4-5 "MiniMite" Equipped with a Temperature Scale

4-6 "MiniMite" Calibrated To The Same Curve As The Instrument Under Test:

4-7 Connect the "MiniMite" to the instrument with thermocouple extension leads of the proper calibration. Zero and standardize "MiniMite" as described in Section 2.

4-8 Turn switch (2) to the "LOCK" position.

4-9 Depress "TEST" button (10) and twist $\frac{1}{4}$ turn to hold in.

4-10 Turn scale knob (1) until the desired check point is reached.

4-11 Balance the potentiometer circuit of the instrument under test. Recorders and self-balancing indicators will balance automatically. Indication of instrument should be the same as that of "MiniMite".

4-12 "MiniMite" NOT Calibrated To The Same Curve As The Instrument Under Test:

4-13 Connect "MiniMite" to instrument under test using extension leads of same calibration as

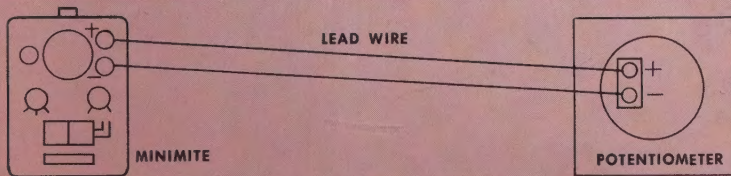


Figure 4. Checking Potentiometer-Type Instruments.

4. CHECKING POTENTIOMETER-TYPE INSTRUMENTS

the "MiniMite" scale used. Zero and standardize instruments.

4-14 Turn switch (2) to "LOCK".

4-15 Depress "Test" button (10) and twist $\frac{1}{4}$ turn to hold in.

4-16 Turn scale knob (1) until desired check point is reached.

4-17 Balance the instrument under test, or if self-balancing, permit instrument to reach stable indication.

4-18 Measure actual temperature at terminals of instrument under test; determine corresponding millivolt correction for scale on "MiniMite" from calibration table.

4-19 In same table, determine millivolt value for "MiniMite" check point; algebraically subtract correction value obtained in 4-18 from the millivolt value. This is the value of millivolt potential applied to terminals of the instrument under test.

4-20 Using calibration table for the scale on instrument under test, determine millivolt correction value corresponding to temperature measured in 4-18.

4-21 Algebraically add correction value (para. 4-20) to millivolt value determined in 4-19. In calibration table for scale of instrument under test, determine corresponding temperature; this should agree with indication of instrument under test.

4-22 *"MiniMite" Equipped with a Combination Temperature-and-Millivolt Scale*

4-23 **"MiniMite" Calibrated To The Same Curve As The Instrument Under Test:**

Follow procedure outlined in paragraphs 4-6 through 4-11.

4-24 **"MiniMite" NOT Calibrated To The Same Curve As The Instrument Under Test:**

4-25 Use millivolt scale and follow procedure outlined in paragraphs 4-27 through 4-39.

4-26 *"MiniMite" Equipped with a Millivolt Scale*

4-27 Connect copper leads from the thermocouple terminal posts of the potentiometer under test to terminal posts of "MiniMite" (5) and (6), observing polarity, + to +, and - to -.

4-28 Zero and standardize the "MiniMite" as described in Section 2.

4-29 Turn range selector switch (8) to appropriate scale.

4-30 Turn function switch (2) to "LOCK" position.

4-31 Depress "Test" button and twist $\frac{1}{4}$ turn to hold in.

4-32 Turn scale knob (1) until desired check point is reached.

4-33 Balance the instrument under test, or if self-balancing, permit indicator or recorder to reach stable indication.

4. CHECKING POTENTIOMETER-TYPE INSTRUMENTS

4-34 If instrument under test is equipped with a millivolt scale, the reading in millivolts may be directly compared with "MiniMite". However, if instrument under test indicates in calibrated scale units such as temperature, this must be converted to equivalent millivolts at its terminals.

4-35 If instrument under test employs a manganin spool (not a temperature responsive compensating spool), refer to temperature-millivolt table for the design reference temperature (75°F for Thermo Electric Co. instruments) at the desired check point to determine the corresponding millivolt indication.

4-36 If instrument under test employs a reference junction compensation spool, correction must be made for the effect of its actual temperature.

4-37 Measure reference junction temperature of instrument under test with thermometer located at its compensating resistor, usually located at input terminals. Find corresponding millivolt value in correct calibration temperature-millivolt table.

4-38 Using same table, find millivolt value corresponding to selected check point reading of instrument under test.

4-39 Algebraically subtract the millivolt value corresponding to actual input terminal temperature (paragraph 4-37) from tabular millivolt value corresponding to check point (paragraph 4-38) to find actual millivolts at terminals of instrument under test. This may be compared with "MiniMite" millivolt indication.

5. CHECKING MILLIVOLTMETER-TYPE INSTRUMENTS

5-1 DIRECT THERMOCOUPLE READINGS

5-2 The calibration of millivoltmeter-type instruments may be checked by reading the thermocouple temperature with the instrument under test, and then comparing this reading with the "MiniMite" reading, when the "MiniMite" is used with a test thermocouple located adjacent to the thermocouple of the instrument under test. Simply follow the appropriate procedure in Section 3, depending upon the scale calibration of the "MiniMite" being used. This is a quick, but at times inaccurate, method of calibration.

5-3 DIRECT COMPARISON OF INSTRUMENTS

5-4 If a more positive method of calibration is desired than that described above, follow the appropriate instructions below, depending upon the scale calibration of the "MiniMite" being used.

5-5 *"MiniMite" Equipped with a Temperature Scale*

5-6 **"MiniMite" Calibrated To The Same Curve As The Instrument Under Test:**

5. CHECKING MILLIVOLTMETER-TYPE INSTRUMENTS

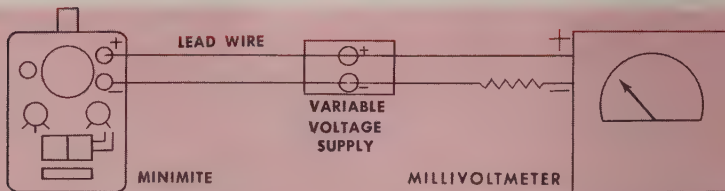


Figure 5. Checking Millivoltmeter-Type Instruments.

NOTE

The instructions below are based on the assumption that the cold junctions of the "MiniMite" and the millivoltmeter remain constant during calibration checks, although the cold junctions of the two instruments need not be the same.

5-7 Zero and standardize the "MiniMite" circuit as described in Section 2.

5-8 Move the range selector switch (8) to the scale calibration of the instrument or thermocouple being calibrated. (When checking millivoltmeters not calibrated to the same curve as the "MiniMite", select either of the two scale positions. See paragraph 5-19).

5-9 Short circuit the terminal posts of the "MiniMite" (5) and (6) with a short length of copper wire.

5-10 Press "Test" button (10). Galvanometer

pointer (7) will deflect. Turn scale knob (1) until galvanometer pointer (7) is at "0". Read the temperature directly on the scale (9).

5-11 The scale reading indicates the "MiniMite" cold-junction temperature, e.g. the temperature of the "MiniMite" terminal posts.

5-12 Short circuit the terminal posts of the millivoltmeter under test with a short length of copper wire.

5-13 Adjust the millivoltmeter to read the same temperature as the "MiniMite" cold-junction temperature (paragraph 5-11). (When checking millivoltmeters not calibrated to the same curve as the "MiniMite" adjust the millivoltmeter to read 75°F, 25°C, or 0 millivolts. See paragraph 5-19).

5-14 Remove the terminal shorting wires from both instruments and connect copper leads from the terminal posts of the "MiniMite" to the terminal posts of the millivoltmeter. OBSERVE POLAR-

5. CHECKING MILLIVOLTMETER-TYPE INSTRUMENTS

ITY, + to +, and - to -. These leads must be of the same resistance as the specified external thermocouple circuit resistance of the millivoltmeter. This resistance value is marked on the millivoltmeter and may be added in series with one of the copper lead wires.

5-15 After following all directions in paragraph 5-14, connect an auxiliary variable current supply to the "MiniMite" terminal posts. This current supply may be a dry cell and rheostat.

5-16 Deflect the millivoltmeter with the variable current source and press the "Test" button (10). Galvanometer pointer (7) will deflect. Turn scale knob (1) until galvanometer pointer (7) is at "0".

5-17 The millivoltmeter should read the same as the "MiniMite". Step 5-16 may be repeated several times to check the millivoltmeter at different points on the scale.

NOTE

After the millivoltmeter has been calibrated, it may be placed back into operation as follows:

(1) measure cold-junction temperature of the millivoltmeter with a glass thermometer, (2) short circuit the terminal posts of the millivoltmeter, and (3) set millivoltmeter pointer to cold-junction temperature.

5-18 "MiniMite" NOT Calibrated To The Same Curve As The Instrument Under Test:

5-19 Follow steps 5-6 through 5-16, and translate the "MiniMite" scale reading to millivolts. Algebraically subtract the millivoltage of the "MiniMite" cold-junction. Translate the resulting millivoltage to temperature, using the temperature-millivolt table corresponding to the calibration of the millivoltmeter being calibrated.

5-20 "MiniMite" Equipped with a Combination Temperature-and-Millivolt Scale.

5-21 "MiniMite" Calibrated To The Same Curve As The Instrument Under Test:

5-22 Short circuit the millivoltmeter terminal posts with a short length of copper wire.

5-23 Adjust the millivoltmeter to read 75°F, 25°C, or 0 millivolts.

5-24 Remove the terminal shorting wire from the millivoltmeter and connect copper leads from the terminal posts (5) and (6) of the "MiniMite" to the terminal posts of the millivoltmeter. OBSERVE POLARITY, + to + and - to -. These leads must be of the same resistance as the external thermocouple circuit resistance of the millivoltmeter. This resistance value is marked on the millivoltmeter and may be added in series with one of the copper lead wires.

5-25 Zero and standardize the "MiniMite" circuit as described in Section 2.

5-26 Move the range selector switch (8) to MV. Connect an auxiliary current supply to the "Mini-

5. CHECKING MILLIVOLT METER-TYPE INSTRUMENTS

Mite" terminal posts. This current source may be a dry cell and rheostat.

5-27 Deflect the millivoltmeter with the variable current source and press the "Test" button (10). Galvanometer pointer (7) will deflect. Turn scale knob (1) until galvanometer pointer (7) is at "0". The millivoltmeter should read the same as the "MiniMite".

5-28 **"MiniMite" NOT Calibrated To The Same Curve As The Instrument Under Test:**

5-29 Follow procedure outlined in paragraphs 5-22 through 5-27 and, by using the temperature-millivolt table, convert the "MiniMite" scale reading in millivolts into temperature corresponding to the calibration of the millivoltmeter.

5-30 *"MiniMite" Equipped with a Millivolt Scale.*

5-31 Follow procedure described in paragraph 5-28.

6. INSTALLATION IN PANEL

6-1 The "Mini-Mite" instrument can be flush-mounted (see Figure 6) in a panel cutout. When used in a permanent installation, the instrument is adapted for flush mounting through the use of a special rear cover equipped with a mounting flange.

6-2 Installation is accomplished by preparing a $5\frac{1}{4}$ " high by 4" wide panel cutout with four mounting holes matching the flange per Figure 7. The "MiniMite" may be installed with or without removal of rear flanged cover, and may be secured

by screws or bolts. To replace battery, the single thumbscrew at rear of case may be removed and "MiniMite" chassis removed from case.

If rear of case is not readily accessible, flange may be dismantled from panel, facilitated by thumbscrew mounting.

6-3 The "MiniMite" is available modified to provide for rear attachment of lead wires. With this modification, both input terminals are located behind the rear cover of the instrument. Attachment of lead wires is accomplished from behind the panel.

7. MAINTENANCE

7-1 When the "MiniMite" is in transit, or when being carried in the course of routine portable testing, switch (2) should be returned to the "LOCK" position. Galvanometer is "shorted" to dampen oscillation.

7-2 When it is no longer possible to standardize the "MiniMite" circuit by turning the STD. ADJ. knob (3), install a new battery. To replace expended battery, remove cover screw on rear cover, remove cover, remove battery, and replace with fresh size D flashlight battery.

CAUTION

Do not place function selector switch in STD. position unless the battery is installed, otherwise a severe current drain will be placed upon the standard cell and will affect its accuracy. OBSERVE POLARITY when replacing the battery. The working range of the standard cell is from 40°F to 140°F, (4.4°C. to 60.°C).

8. REPLACEMENT PARTS

8-1 When ordering replacement parts, always refer to the serial number stamped on the in-

strument nameplate. The following replacement parts for the "MiniMite" are available from Thermo Electric Co., Inc.



Figure 6. "MiniMite", Flush-Mounted in Panel.

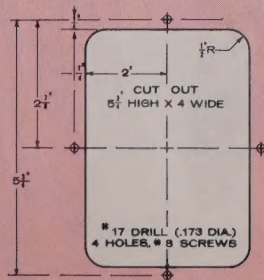


Figure 7. Mounting Dimensions, "MiniMite".

Part

Name

- 7552-1 Binding post terminal, black
 7552-2 Binding post terminal, red
 A 1751 Galvanometer
 7936 Battery (size "D" flashlight cell)
 7587 Knobs, range selector and function selector
 A 1561 Knob, standardizing adjustment

Part

Name

- 7631 Leather carrying case, with strap
 7633 Standard cell
 7647 Mounting screw (back of instrument case)
 A 1776 Test switch (micro)
 A 1772 Pushbutton switch (for test switch)
 A 1761 Standardizing adjustment rheostat

-
-
1. Scale knob
 2. Test button
 3. 23.6 inch scale
 4. Range selector
 5. Standardizing adjustment
 6. Binding post terminals
 7. Reference junction compensating resistor
 8. Galvanometer
 9. Standard cell housing
 10. Battery
-
-

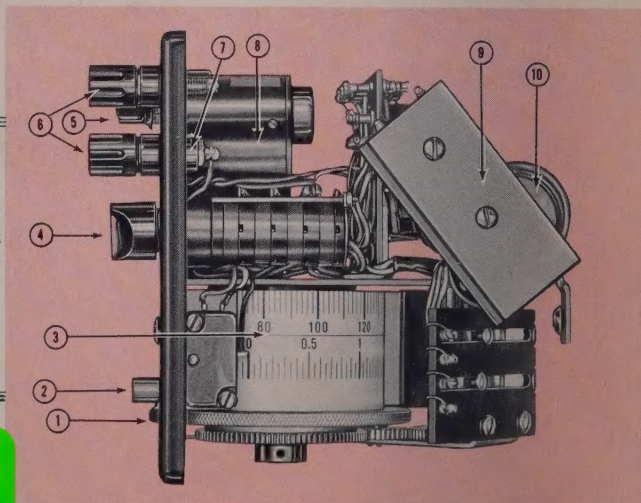
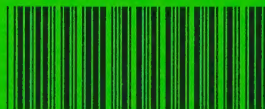


Figure 8. "MiniMite", Cover Removed.

MP MASTER



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